

ACCESSION #: 9103010089
LICENSEE EVENT REPORT (LER)

FACILITY NAME: DIABLO CANYON UNIT 1 PAGE: 1 OF 24

DOCKET NUMBER: 05000275

TITLE: REACTOR TRIP AND SAFETY INJECTION FROM STEAM LINE
DIFFERENTIAL
PRESSURE SPURIOUS SIGNALS
EVENT DATE: 10/06/89 LER #: 89-009-01 REPORT DATE: 02/21/91

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:

50.73(a)(2)(iv) & OTHER: Supplement 1 to NUREG-1022

LICENSEE CONTACT FOR THIS LER:

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COMPLIANCE ENGINEER

COMPONENT FAILURE DESCRIPTION:

CAUSE: B SYSTEM: SG COMPONENT: OL MANUFACTURER: A109
REPORTABLE NPRDS: N

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On October 6, 1989, at 1302 PDT, with Unit 1 in Mode 1 (power operation) at 100 percent power, an automatic safety injection/reactor trip was actuated from a steam line differential pressure signal. At 1321 PDT, a 1-hour emergency report was made in accordance with 10 CFR 50.72(a)(1)(i).

During the removal from service process for calibration of a pressure transmitter for an atmospheric steam dump valve (ADV) control, pressure oscillations were created in the common sensing line with a protection set steam generator pressure transmitter. This caused repeated actuations of a steam line differential pressure bistable. The bistable actuation, combined with a previously tripped steam pressure bistable, satisfied the 2/3 coincidence logic to generate a steam line differential pressure SI signal.

The I&C removal from service/calibration procedure was inadequate in that it did not verify the condition of other channel bistables to ensure that coincident logic could not be satisfied. I&C procedures were revised to assure that work on equipment sharing a common process tap is not performed if any of the shared instrumentation is in a configuration that produces a protection actuation or control function. Actions for associated events included developing a policy for guidance on tripped bistables, developing a procedure to control non-TS equipment called upon in emergency conditions, developing training on the characteristics of ADVs, issuing an operations order for normal operation of the steam space sample line, and revising testing to include the dynamic properties of PORVs.

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END OF ABSTRACT

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I. Plant Conditions

Unit 1 was in Mode 1 (Power Operation) at approximately 100 percent power. The unit was in a reactor coolant system (RCS) temperature coastdown with RCS temperature 4 degrees F below the reference average temperature program in preparation for the third refueling outage.

II. Description of Event

A. Event:

Unit 1 was at 100 percent reactor power, and all operating parameters were normal with the exception of RCS average temperature, which was approximately 4 degrees lower than the reference average temperature program because of an end-of-life temperature coastdown in progress. Pre-outage work was in progress in preparation for the refueling outage.

Steam flow channels (SB)(CHA) and steam pressure channels (SB)(CHA) associated with Reactor Protection Set 2 were out of service with the protection and safeguards bistables (1PC-515A and 1PC-515B, steam generator differential pressure, and 1PC-513, 523, 533 and 543, high steamline flow) (JE) tripped for implementation of a planned digital feedwater control system design change. Main steam supply system atmospheric

dump valves (ADV) (SB) (PCV) 1-PCV-19 and 1-PCV-20 had been manually isolated for performance of Instrumentation and Controls (I&C) Loop Tests 4-36E and 4-36F, respectively.

Two I&C technicians were performing Loop Test 4-36F on steam pressure channel 1PT-526A for calibration of 1-PCV-20. A technician closed the isolation valve for 1PT-526A approximately one turn, at which point both technicians heard noise above in the pipe racks. They immediately returned the isolation valve to its full open position. The technicians heard additional noise, followed by a public address announcement of reactor trip.

The safety injection (SI) and reactor trip occurred at 1302 PDT. The Shift Supervisor declared an Unusual Event in accordance with emergency procedures.

Investigation following the event showed the cause to be the generation of pressure oscillations produced by closing the pressure transmitter isolation valve. The 1PT-526A transmitter and its isolation valve share a common sensing line and root valve with steam generator (SB)(SG) pressure transmitter (Protection) (JE)(PT) 1PT-526. Closing the isolation valve resulted in the generation of pressure oscillations, which caused a series of low

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steamline pressure and low SG pressure alarms. This oscillation repeatedly actuated and cleared low steamline pressure, SG 1-2 steamline differential pressure, and SG 1-3 steamline differential pressure bistables. The SG 1-3 steamline differential pressure bistable actuation, combined with the previously tripped pressure channel 515 bistable (1PC-515B), satisfied the 2/3 coincidence logic to generate a SG 1-3 differential pressure SI signal.

The post-trip cooldown resulted in average RCS temperature reaching the low-low Tavg setpoint. This, combined with the previously tripped high steam flow bistables, satisfied the logic required to actuate a main steam isolation signal. The four main steam isolation valves (MSIVs) (SB)(ISV) closed at 1303 PDT.

Circulating Water Pump (CWP) 1-2 (SB)(P) had been selected to automatically restart following 12 kV bus transfer. CWP 1-2 did not restart. Restart relay 2VE5A failed open due to a failed relay coil (SG)(CL). The loss of circulating water flow resulted in a loss of condenser (condenser available interlock C-9) and condenser steam dump (40 percent steam dump) availability.

When primary system pressure decreased to 2200 psig, operators shut pressurizer spray valves (ASS)(PZR)(INV) at 1307 PDT in response to decreasing pressure in accordance with Emergency Procedure (EP) E-0, "Reactor Trip or Safety Injection." RCS cooldown was terminated when auxiliary feedwater flow was reduced. Following this, RCS heatup from decay heat and reactor coolant pump (RCP) (AB)(P) heat input began. Pressurizer pressure was increasing due to a combination of swell of RCS coolant from heatup and emergency core cooling system (ECCS) inflow. At 1308 PDT operators shut off pressurizer heaters (AB)(PZR)(EHTR) in response to increasing pressurizer pressure that was above its normal operational value. At 1310 PDT, pressurizer power-operated relief valve (PORV) 1-PCV-455C (AB)(PCV) cycled open several times to relieve primary pressure due to increasing pressurizer pressure.

By 1321 PDT, operators had reset the SI signal and had shutdown the reciprocating charging pump (BQ)(P), one centrifugal charging pump (BQ)(P), both SI pumps (BQ)(P) and both residual heat removal pumps (BP)(P) to reduce ECCS inflow in accordance with EP E-1.1, "SI Termination," since pressurizer level was greater than 70 percent at this time.

As required by 10 CFR 50.72(a)(1)(i), a one-hour emergency report was completed at 1321 PDT.

At 1330 PDT, operators attempted to open the two available ADVs, 1-PCV-21 and 1-PCV-22, to terminate RCS temperature rise and

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corresponding pressurizer level rise. The 1-PCV-21 control room hand controller was manually raised to 25 percent demand with no immediate change in valve position indication lights or

steam flow indications. The 1-PCV-22 control room hand controller was then manually raised to 40 percent. No indication changes were immediately noted by the operator, who then returned the controller demand to 0 percent. A non-licensed operator was dispatched to locally check the valves condition.

By 1331 PDT, CWP 1-2 and the condenser vacuum pump (SH)(P) were started to restore condenser vacuum to allow use of the condenser steam dumps.

AT 1340 PDT the operator dispatched to investigate the ADV 1-PCV-22 local conditions responded that all appeared normal. 1-PCV-22 control room demand was increased to 45-50 percent and the valve opened and controlled normally from the control room.

The operator dispatched to investigate ADV 1-PCV-21 noticed that the valve had about 4 psi control air pressure indicated (control air pressure ranges from 3 to 15 psi over 0 to 100 percent valve open), and notified the control room of the conditions. The control room increased demand on 1-PCV-21 to 45-50 percent and observed that the valve opened and responded normally.

At 1341 PDT, operators established normal RCS letdown and placed excess letdown in service to stop the pressurizer level increase. Charging flow was reduced to minimum. RCP seal injection flow was maintained throughout plant recovery from the trip.

At 1343 PDT, operators opened two MSIV bypass valves in preparation for opening MSIVs to limit RCS heatup. RCS temperature then started decreasing due to steam dump and MSIV bypass. Low-low Tavg was again reached, initiating steamline isolation at 1344 PDT. (Steamline high flow bistables were still tripped because of work in progress prior to the reactor trip.)

At 1345 PDT, operators shut down RCPs 1-1 and 1-3 to reduce RCS heat input and pressurizer level swell. Pressurizer level swell was terminated with a maximum level of 97 percent at 1346 PDT.

At 1358 PDT, Protection Set 2 steam pressure and flow channels were returned to service to prevent further steamline isolation signals. ADVs 1-PCV-19 and 1-PCV-20 were also returned to

service. 1-PCV-20 was opened to stabilize RCS temperature.

Beginning at 1411 PDT, the MSIVs were opened, and the condenser steam dump system was placed in service. ADVs were closed and

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returned to their standby configuration. The unit was stabilized in Mode 3 (Hot Standby) at 1430 PDT.

B. Inoperable Structures, Components, or Systems That Contributed to the Event:

1. The Protection Set 2 steam flow and steam pressure channels were out of service with the protection and safeguards bistables (1PC-515A and 1PC-515B, SG differential pressure, and 1PC-513, 523, 533 and 543, high steamline flow) tripped for preliminary work on a planned digital feedwater control system design change.
2. ADVs 1-PCV-19 and 1-PCV-20 had been removed from service in preparation for performance of I&C Loop Tests 4-36E and 4-36F, respectively.

C. Dates and Approximate Times For Major Occurrences:

1. October 6, 1989, at 1302 PDT: Reactor trip and steam line differential pressure safety injection. Unusual Event declared.
2. October 6, 1989, at 1310 PDT: Pressurizer PORV 1-PCV-455C due to increasing pressurizer pressure.
3. October 6, 1989, at 1345 PDT: RCPs 1-1 and 1-3 were shutdown.
4. October 6, 1989, at 1346 PDT: Pressurizer level increase terminated. Level peaks at 97 percent.
5. October 6, 1989, at 1430 PDT: Plant stable in Mode 3. Shift Supervisor terminates

Unusual Event.

D. Other Systems or Secondary Functions Affected:

1. Main Steamline Isolation

Main steamline isolation occurred because the bistables associated with high steam flow in Reactor Protection Set 2 were tripped in order to facilitate pre-outage preparations for main feedwater control system modifications. Two of the tripped steamline flow bistables, coincident with a low-low

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Tavg as a result of the RCS cooldown, satisfied the logic for main steam isolation.

The cause of the event was work in progress on the feedwater control system in preparation for the refueling outage, which required placing the SG 1-1 bistables in the tripped condition. This resulted in completion of half the logic for main steam isolation. A second cause was personnel error, in that I&C technicians did not recognize the effect of operation of the common tap isolation valve for 1PT-526A on 1PT-526. The operation of 1PT-526A resulted in actuation of SG 1-2 bistables, causing a reactor trip and subsequent RCS temperature reduction to the low-low Tavg setpoint. Reaching the low-low Tavg setpoint completed the logic required for main steam isolation.

2. Two ADVs Out of Service

A review of plant emergency operating procedures indicates that the SG ADVs are to be utilized for RCS cooldown whenever the main condenser steam dump system is unavailable.

At the time of the reactor trip, two out of the four ADVs (1-PCV-19 and 1-PCV-20) had been removed from service for the performance of loop tests. The ADVs are not governed by the Technical Specifications (TS) as active components but as containment isolation valves. No plant procedures

existed to control clearances on equipment required for Emergency and Abnormal Operating procedures that is not specifically addressed by the plant TS.

Although not explicitly stated in the plant administrative controls or operating procedures, it has been a general practice that no more than two ADVs may be cleared at any one time. This is based on the premise that long-term heat removal by at least two SGs must be maintained.

A review of the Final Safety Analysis Report (FSAR) Update Chapters 6 and 15 safety analyses has determined that the ADVs are not required except for steam generator tube rupture (SGTR). The SGTR analysis implicitly assumes plant cooldown is performed by means of manual operation of the ADVs (assuming loss of the steam condenser due to loss of power). A recent SGTR analysis performed by Westinghouse, which has been submitted to the NRC but not approved, explicitly models the ADVs. The SGTR analysis models plant cooldown via the three intact SGs (and manual operation of the associated ADVs).

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Based on SGTR analysis, it is non-conservative for any ADV to be unavailable for plant cooldown, and if one ADV is unavailable, the duration should be limited.

The cause of the ADVs being out of service was inadequate control of plant equipment required to be in service for Emergency and Abnormal Operating Procedures. No procedures existed to control clearances on equipment that is not specifically addressed by the plant TS. The TS were considered by the personnel involved to be the only document required to ensure availability/operability of equipment required for accident mitigation and safe shutdown.

3. ADVs 1-PCV-21 & 1-PCV-22 Initial Failure To Open

The failure of the ADVs to initially open was the operators' unawareness of the demand signal versus valve stroke characteristics. Not all operators were aware that the ADVs would require approximately 20 percent control

room demand to fully open the pilot valve prior to beginning to open the main plug and releasing steam. This characteristic was not generally known because the training of the operators did not emphasize the actuator control characteristics associated with the ADVs. The DCPD simulator did not accurately model the ADV pilot valve operation. Operators were accustomed to the ADV opening at low manual demand values on the simulator. Time delay in ADV response is also due to long instrument tubing runs.

Additionally, valve response was degraded due to inadequate testing and preventive maintenance. The current-to-pneumatic (I/P) devices had experienced some electronic drift. This delayed ADV opening to a greater demand signal than expected. This problem was not apparent in the existing valve testing program since this program consisted only of a timed stroke test and was only performed on an 18-month interval.

4. Pressurizer PORV, 1-PCV-455C, Lifted Below Setpoint and Cycled Repeatedly

1-PCV-455C lifted during the event at a pressure lower than its prescribed setpoint of 2335 psig. This occurred because the accepted operating practice was to operate with back-up heaters manually turned on and a lowered setpoint on the pressurizer master pressure controller, HC-455C, to a point where the system controlled at 2235 psig. This operating practice was used to promote good pressurizer/RCS mixing and prevent boron concentration increases in the pressurizer due

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to continual steaming in the pressurizer. The opening of 1-PCV-455C could occur since the pressurizer master pressure controller setpoint was reduced to maintain normal operating pressure with spray flow, and to enhance pressurizer/RCS mixing.

The lowered control setpoint directly lowered the 1-PCV-455C setpoint. It was generally felt by the plant operators and plant management that it was necessary to

maintain the steam space sample valve open at all times for proper pressurizer operation. Subsequent testing indicated that this was not necessary.

The cause of early opening of the PORV during the transient was that operating practices were in error, in that the setpoint had been changed to operate the pressurizer in an unnecessary configuration.

The cause for 1-PCV-455C opening and closing rapidly is inadequate maintenance and testing procedures. The I&C procedures used to set up and test this control system did not include testing of the dynamic properties of the system, as this was not thought to be necessary. Since the dynamic properties of the system were not tested, a disconnected capacitor was not identified. The capacitor is intended to prevent rapid cycling of the PORV.

5. Pressurizer Level Transient During SI Recovery

The pressurizer level increased to 97 percent of span during recovery from the event. This level increase was due to the extra mass injected into the system by the ECCS injection, coupled with the RCS water swell caused by RCS heatup following auxiliary feedwater (AFW) flow reduction. This level swell was exaggerated by steamline isolation, which caused the RCS heatup to be greater in magnitude and faster than the heatup normally experienced with the steamlines not isolated.

The pressurizer level transient was a normal response for this situation.

E. Method of Discovery:

The event was immediately apparent to control room operators from main annunciator alarms and other control room indications.

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F. Operator Actions:

1. The operators stabilized the unit in Mode 3 using EPs E-0

and E-1.1.

2. Because of the initial steamline isolation and loss of the condenser steam dump system, the operators manually opened the ADVs to stabilize RCS temperature and pressurizer level.

3. RCPs 1-1 and 1-3 were shut down to reduce heat input to the RCS.

4. The Shift Supervisor directed that the Protection Set 2 steam pressure and steam flow channels be returned to service.

5. The Shift Supervisor directed that ADVs 1-PCV-19 and 1-PCV-20 be returned to service.

6. CWP 1-2 and the condenser vacuum pump were manually started to re-establish condenser vacuum.

7. Excess letdown was placed in service to limit pressurizer level increase.

G. Safety System Responses:

1. All Engineered Safety Features (ESF) equipment started as designed in response to SG differential pressure SI signal.

2. The reactor trip breakers (JC)(BKR) opened.

3. The control rod drive mechanism (AA)(DRIV) allowed the control rods to drop into the reactor.

4. MSIVs and MSIV bypass valves closed per design in response to high steamline flow coincident with low-low Tavg signal.

5. AFW pumps (BA)(MO)(P) started per design.

6. Pressurizer PORV 1-PCV-455C cycled open and closed to relieve RCS pressure.

7. Diesel Generators (EK)(DG) 1-1, 1-2, and 1-3 started, and per design did not load.

III. Cause of Event

A multi-disciplinary event response team was formed to investigate the event. The team reviewed the human factors and the equipment/material factors associated with this event.

The event response team investigation into the SI/reactor trip determined that, based on all available information, the scenario for the pressure oscillation is as follows.

When the sensing line isolation valve for 1PT-526A was manipulated, the displaced water created a surge in the sensing line. It is postulated that this surge reacted against the steam pressure at the steam/water interface (in the vicinity of the root valve) creating a surge back down the sensing line that reacted against the bourdon tube in the protection transmitter (1PT-526). As the isolation valve was being turned, these surges continued to recur at the acoustic resonant frequency of the sensing line, approximately 15 Hz. The transmitter output followed the oscillating pressure signal.

The postulated scenario described above has been duplicated by testing in the cold condition, using nitrogen as the compressible gas. The sensing line was filled with water to the approximate level of the normal operating steam/water interface, and a small, nitrogen cover gas space was pressurized to approximately 750 psig. The isolation valve for 1PT-526A was manipulated, and pressure oscillations on the 1PT-526 output of approximately the same amplitude were created and recorded.

Several other attempts were made to recreate and to determine the source of the 1PT-526 transmitter response. These included:

- 1) The 1PT-526A isolation valve was cycled several times under the same pressure conditions, but with no steam flow. No change in the output of 1PT-526 was noted. It is postulated that the steam/water interface during this testing had moved to a region in the sensing line where its displacement would not result in compression of steam. Thus, there was no pressure surge energy addition, and the pressure oscillations could not be duplicated.

2) The output of 1PT-526 was monitored while the transmitter was mechanically vibrated at frequencies of 0-25 Hz and at random noise frequencies. No significant change in the output of 1PT-526 was noted.

3) Attempts were made to electrically excite the output of 1PT-526 by keying a radio transmitter in the vicinity of the 1PT-526 mechanical panel. No change in the output of 1PT-526 was noted.

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4) A channel calibration check was performed on 1PT-526. The as-found test data were within specification.

5) The routing of the 1PT-526 signal cable was checked against locations for plant welding and burning permits to determine if any interference could have generated the pressure oscillations. A total of 17 permits were identified. These were individually reviewed with the associated job foremen to determine if any actual welding was being performed at the time of the pressure transmitter oscillations. No potential interaction items were found.

6) The common sensing line for 1PT-526 and 1PT-526A was filled with water, pressurized to 750 psig, and capped at the root valve. The input for 1PT-526A was step changed and the output of 1PT-526 monitored by a high speed recorder. The output of 1PT-526 was as expected, with no pressure oscillations.

The transmitter vendor (ITT Barton) was contacted. The vendor stated that this problem has not been seen before, but they believed that output of the transmitter accurately reflected actual oscillations on the pressure input.

A. Immediate Cause:

SG pressure bistable 1PC-526D tripped when steamline pressure transmitter 1PT-526 sensed pressure oscillations following manipulation of the isolation valve for steam pressure transmitter 1PT-526A. 1PT-526 and 1PT-526A share a common sensing line and instrument root valve. The tripping of bistable 1PC-526D, in conjunction with one of the other protection set steam pressure bistables (1PC-515B) which was

already tripped, satisfied the logic (2/3) for SG 1-3 differential pressure SI.

B. Root Cause:

The I&C Loop Test for calibration of the pressure transmitter for an SG ADV contained a precaution stating "slowly cut the transmitter in and out as it shares a tap with a protection set transmitter". The precaution was inadequate in that even slowly moving the isolation valve would not mitigate sensing line perturbation. The system sensitivity and response anomaly was unknown to management at the time of procedure development/revision.

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C. Contributory Cause:

A contributory cause is the design of the process tap/sense line design installation, in that a common (shared) tap was specified for a control function channel and a protection function channel.

IV. Analysis of Event

A. Safety Injection/Reactor Trip

This event resulted in a spurious SI from full power, which is a previously analyzed Condition II event. The FSAR Update analysis does not take credit for a simultaneous reactor trip with SI, but conservatively assumes that reactor trip is not actuated until the low pressurizer pressure setpoint is reached. This event, in which a simultaneous reactor trip did occur, is bounded by the FSAR Update analysis. Thus, the health and safety of the public were not adversely affected by this event.

B. Main Steamline Isolation

Main steamline isolation constitutes an ESF actuation. Steamline isolation is an expected result of a steam flow signal coincident with a low-low Tavg signal or a low steamline pressure signal. This actuation represents a conservative change in plant configuration, and is bounded by the Condition

II safety analysis in the FSAR Update. Thus, the health and safety of the public were not adversely affected by this event.

C. Two ADVs Out of Service

Although two ADVs were out of service at the time of the reactor trip and SI, the ADVs were not being physically worked. The two ADVs had been manually isolated to prevent steam release during their respective steam pressure channel loop test performance. It is general operating practice to limit ADV physical maintenance to a single ADV at a given time while at power.

During the recovery, ADVs 1-PCV-19 and 1-PCV-20 were subsequently placed in service. Although initially unavailable, the ADVs were returned to service and were subsequently utilized for temperature control. In the event that an SGTR had occurred rather than the spurious SI, the ADVs could have been made available for plant cooldown. As shown during the recovery of the SI/reactor trip event, ADVs 1-PCV-19 and 1-PCV-20 were able to be placed in service and used for plant temperature control. Thus, ADVs 1-PCV-19 and 1-PCV-20 being cleared for calibration testing did not have an adverse affect on plant safety.

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D. ADVs 1-PCV-21 & 1-PCV-22 Initial Failure To Open

As determined by the investigation, ADVs 1-PCV-21 and 1-PCV-22 were considered to have functioned correctly. Although the initial attempts to open ADVs 1-PCV-21 and 1-PCV-22 were unsuccessful due to lack of operator patience, subsequent attempts to open the ADVs were successful and the plant was stabilized in Mode 3. Thus, the health and safety of the public were not adversely affected.

E. Pressurizer PORV 1-PCV-455C Lifted Below Setpoint

The PORVs are designed to limit pressurizer pressure to a value below the high pressure reactor trip setpoint for all design transients. The PORVs are designed to reduce RCS pressure prior to opening of the pressurizer safety relief valves. Opening of the PORVs is preferred since they are isolable, and

the safety relief valves are not. In the event of a PORV becoming stuck open the PORV can be isolated. In this event, RCS integrity could still be maintained by the operators. The overpressurization limits of the RCS would not be challenged, and a stuck-open PORV is bounded by the Condition II event of a stuck-open safety relief valve. Thus, the health and safety of the public were not adversely affected by this event.

F. Pressurizer PORV 1-PCV-455C Cycled Repeatedly

A review of post-trip data and interviews with operations personnel indicated that pressurizer PORV 1-PCV-455C lifted several times at a pressure lower than expected.

Pressurizer PORV 1-PCV-455C is included in the pressurizer pressure control scheme. In response to increasing pressure, the pressurizer pressure controller actuates pressurizer spray, takes pressurizer proportional heaters to minimum, and will open 1-PCV-455C. The pressurizer pressure controller has both proportional and integral (reset) features. The proportional feature causes the output to respond proportionally to the input while the integral feature causes the output to integrate either up or down until the selected setpoint is satisfied.

Prior to the event, the control and operating conditions were: (1) pressure controller set to control at 2210 psig; (2) some backup heaters on (manually); (3) the proportional heaters at minimum; and (4) spray valves partially open. This configuration was established to maintain sufficient flow through the pressurizer, via spray, to keep boron concentration within 50 parts per million of the primary coolant concentration.

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With the backup heaters on, the pressurizer pressure tends to increase, depending on spray flow. The pressure controller will integrate its output up until the spray valves are driven open enough to counteract the effect of the heaters. This creates a situation where the controller output is closer to where PORV 1-PCV-455C opens.

Following the SI and reactor trip, primary system pressure and the pressurizer pressure started to rise. As the controller

output was already increased as described above, and the pressurizer spray valves had been put in manual and closed in accordance with EP E-0, the added proportional action of the controller in response to the pressure increase was sufficient to increase the controller output to a level causing the PORV to open.

In its investigation of pressurizer PORV 1-PCV-455C lifting several times, I&C performed a calibration of the pressurizer pressure controller. During the calibration verification process, the summator was inspected internally and found to have a capacitor, in the portion of the circuit that creates the "open to shut" dead band, that was not properly connected. This eliminated the dead band and allowed the valve to open and shut in rapid succession while the controller output was at the setpoint. However, the absence of the dead band did not affect the PORV opening circuitry and did not degrade its ability to respond to increasing pressure. While cycling of the valve could potentially have presented an increased risk for valve failure, the associated block valve was available to mitigate the consequences if such an event had occurred.

A review of the plant operating conditions, the status of the calibration of the control system, and the system responses during the event concluded that the control system and the valve functioned per design with the exception of the valve opening and closing several times due to the absence of the dead band. Thus, the health and safety of the public were not adversely affected.

G. Pressurizer Level Transient During SI Recovery

The pressurizer level reached a maximum of 97 percent of span during this event. The pressurizer level was normal given the conditions of the event. In the event of pressurizer level surpassing 100 percent of span, reactor coolant would begin to drain through the PORVs. The flow would be isolable downstream of the PORVs and upstream of the pressurizer relief tank (AB)(PZR)(TK) by using the pressurizer block valves (AB)PZR(MOV). This would limit drainage of reactor coolant from the RCS and prevent the core from being uncovered. Thus, the health and safety of the public were not adversely affected by this event.

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V. Corrective Actions

A. Immediate Corrective Actions:

1. The unit was stabilized in Mode 3.
2. An event response team was formed to investigate the event.

B. Corrective Actions to Prevent Recurrence:

1. Safety Injection/Reactor Trip

a. The I&C department has provided the Operations department with a listing of instruments that share a common process tap. The listing includes instruments that serve protection, control and indication functions. This listing was intended as an interim measure, and provided Operations department personnel with the necessary information to ensure that work activities on instruments with shared process taps will not result in unplanned protection signal generation or control perturbations.

b. The I&C department has revised test procedures to ensure that work on equipment that shares a common process tap is not performed if any of the shared instrumentation is in a configuration that could produce a protection actuation or control actions.

2. Main Steamline Isolation

A plant policy was developed to provide guidance on leaving protection or safeguards bistables in the tripped condition for extended time periods.

3. Two ADVs Out of Service

An administrative procedure was developed to control clearances for equipment that is not specifically addressed by plant TS, but is called upon to operate in response to emergency conditions.

4. ADVs 1-PCV-21 & 1-PCV-22 Initial Failure To Open

a. Operator training on the ADVs was developed to address the following:

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1) The pilot valve in the ADV requires 20 percent demand signal to fully open.

2) The main plug does not open until the pilot valve is fully open.

3) Rapidly increasing the control room hand controller will result in a higher apparent demand (30 to 40 percent) to initially open the ADV.

4) The ADV has a long run of control air tubing that causes a lag in the control loop.

b. Manual operation of the ADVs has been more accurately modeled in the DCPD simulator.

c. Surveillance Test Procedure (STP) V-3R1, "Exercising 10 Percent Atmospheric Dump Valves PCV-19 & 20 & 21 & 2," was revised to stroke the ADVs quarterly. The revision added detail to check for proper valve response to manual controller inputs.

5. Pressurizer PORV (PCV-455C) Lifted Below Setpoint and Cycled Repeatedly

a. A standing shift order is in place to operate with the pressurizer steam space sample line valve closed and to maintain only enough pressurizer heater groups in service to maintain RCS pressure at 2235 psi. The setpoint on the pressurizer pressure master controller is to be set at the point required to maintain steady state pressure at 2235 psi.

b. The I&C department revised the loop test program to include testing of the dynamic properties of the system.

6. Pressurizer Level Transient during SI Recovery

The pressurizer level transient was caused by the plant response to the SI/Reactor Trip, and was a normal response to this situation. No corrective action is necessary.

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VI. Additional Information

A. Failed Components:

The CWP restart relay, 2VE5A, failed due to an open relay coil. The relay is an Agastat 2400 series relay.

B. Previous LERs on Similar Problems:

None.

C. Background Information on ADV Control:

1. ADV Operational Summary

The Diablo Canyon Power Plant (DCPP) ADVs are 8-inch, Copes-Vulcan model D-100, pneumatic diaphragm, direct acting, vertically mounted, plug type valves with horizontal actuation. To open the ADV, the control air pressure is increased, increasing the supply air pressure and lowering the valve actuator diaphragm, which moves the valve stem down (or into the valve body). This motion first moves the ADV inner plug (pilot) downward inside the main plug. This action allows a small passage of steam from the lower valve cavity (or chamber) to the top of the main plug through to atmosphere. The steam pressure on the top and bottom of the valve plug equalizes, allowing further positioner diaphragm motion to unseat the main plug and exhaust steam (entering the plug from a horizontal direction) to atmosphere.

The control room controller provides a current demand signal to a I/P converter that generates a control air signal. The control air signal is provided to a valve positioner that regulates the supply air pressure to the valve actuator. Actual valve position is compared to the

demand position with the valve positioner increasing or decreasing its output pressure until the ADV moves to its proper position.

2. Event Investigation Scope

An investigation into the lack of initial response of ADVs 1-PCV-21 and 1-PCV-22 was conducted. The investigation included the following:

- a. Post-event ADV stroke tests with maintenance and I&C observation.
- b. Performance of I&C Loop Tests to determine as-found condition.
- c. Mechanical disassembly and inspection.

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- d. Analysis of valve condition by onsite vendor representative.
- e. DCPM maintenance history search and review for ADVs.
- f. Nuclear Plant Reliability Data System (NPRDS) search and analysis for Copes-Vulcan D-100 valves
- g. Nuclear Operation and Maintenance Information System (NOMIS) query on D-100 valves.
- h. Trip to Palo Verde Nuclear Generating Station (PVNGS) to examine corrective actions on ADV failures.

The following details the results of the event investigation.

- a. Post-event ADV stroke tests with maintenance and I&C observation.

ADV 1-PCV-21 and 1-PCV-22 were physically stroke tested under cold (no steam pressure) conditions. The intent of this stroke test was to determine if any valve hysteresis or binding was evident. The test was performed by slowly increasing the control room controller demand while monitoring valve response. The following observations were made:

1-PCV-21

- Air began entering the actuator at a demand of 4 percent.
- Stem travel began at 6 percent demand.
- A slight hesitation in stem travel was observed at approximately 35 percent demand.

1-PCV-22

- Air began entering the actuator at a demand of 14 percent.
- Stem travel began at 17 percent demand.

A stroke test on 1-PCV-21 and 1-PCV-22 was conducted by rapidly raising control room controller demand. Both valves began to open when controller demand indicated approximately 40 percent demand. The physical location of the ADV I/P converters is relevant to this test. The converters are located near the hot shutdown panels to allow for ADV control in emergency conditions. This location results in long (approximately 100 feet) control air tubing runs with an associated air signal time lag.

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b. Performance of I&C Loop Tests to determine as-found condition.

I&C Loop Tests were performed on ADVs 1-PCV-21 and 1-PCV-22 under cold (no steam pressure) conditions, with the following results:

1-PCV-21

- The control room controller demand signal was raised slowly with valve stem motion beginning at 4 percent demand.
- Control room demand signal was raised rapidly with valve stem motion beginning when controller demand indicated approximately 30 percent demand.
- The actual valve position was slightly higher than the desired demand valve position. The control room controller demand position would

result in an ADV position that was slightly further open than the desired demand position.

- Full supply air pressure of approximately 80 psi was verified.

1-PCV-22

- Control room controller demand signal was raised slowly with valve stem motion beginning when controller demand indicated 16 percent demand.

- Control room demand signal was raised rapidly with valve stem motion beginning when controller demand indicated approximately 40 percent demand.

- Although the ADV did not open until 16 percent demand, the valve position was full open at a control room demand of approximately 85 percent.

- Full supply air pressure of approximately 80 psi was verified.

c. Mechanical disassembly and inspection.

The ADVs were disassembled with the following conditions observed:

1-PCV-21

- Some roughness existed on the area of plug/seat interface.

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- The plug piston ring was scratched/galled around the entire surface. A matching condition was noted in the balancing cylinder.

- The valve chamber cover was pitted in the area of the gasket between the cover and balancing cylinder.

- The balancing cylinder gasket was significantly degraded.

- There was evidence that the balancing cylinder and valve cage were not adequately made up.

This would affect the compression of the balancing cylinder gasket.

- The pilot travel was determined to be approximately 3/16 inch.

1-PCV-22

- Some roughness existed on the area of plug/seal interface.
- An apparent minor steam cut was found on the plug.
- The plug piston ring and the balancing cylinder were found to be in acceptable condition.
- The valve chamber cover was pitted in the area of the gasket between the cover and balancing cylinder.
- The balancing cylinder gasket was significantly degraded.
- The pilot travel was determined to be 9/32 inch.

d. Analysis of valve condition by onsite vendor representative.

A Copes-Vulcan representative performed an onsite inspection of the ADVs. The following summarizes the vendor findings:

- The roughness found in the area of the plug/seal interface is not abnormal and would not adversely affect ADV operation. DCPD had previously changed the seating angle to prevent plug sticking, therefore plug sticking is not considered a contributing factor to this event.
- The apparent steam cut on the plug did not significantly affect ADV performance.
- The scratching/galling of the piston ring and balancing cylinder on 1-PCV-21 is not considered to have significantly affected ADV operation.

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- The vendor considers the degradation of the balancing cylinder gasket to be caused by corrosion buildup on the body flange and valve cover mating surfaces. This can contribute to inadequate compression of the balancing cylinder

gasket. Inadequate loading can result in gasket degradation, and result in a slower depressurization of the valve chamber when the pilot valve is opened. The vendor has performed calculations that show the chamber adequately depressurizes under conditions of a degraded balancing cylinder gasket and severely degraded plug piston rings.

e. DCPD maintenance history search and review for ADVs.

Component work order history files and Action Request history files were reviewed for previous ADV problems. Isolated instances of valve hysteresis and slow response were identified. The review concluded that these problems identified with the ADVs were adequately addressed.

f. NPRDS search and analysis for Copes-Vulcan D-100 valves.

An NPRDS search for Copes-Vulcan valves was performed. A summary of the search results identified the following possible causes of valve misoperation:

- Various instrumentation problems or failures.
- Dirty internals or debris.
- Packing nuts too tight.
- Lack of stem lubrication.
- Brass bushings chipped or degraded.

The disposition of the NPRDS concerns is as follows:

- While the maintenance history search for the DCPD ADVs did identify various instrument and control problems, the problems were corrected and do not indicate a major reliability concern.
- Valve disassembly following the October 6 event did not reveal any ADV contamination by dirt or debris.
- DCPD has procedural guidelines related to ADV packing gland follower bolt torquing.
- Stem lubrication was identified as a corrective action for some of the maintenance work orders

identified in the maintenance history search for ADVs. Inadequate stem lubrication is not a chronic problem at DCP, and no evidence of lack of lubrication was noted in this event.

- The Copes-Vulcan vendor representative stated that Copes-Vulcan does not stock brass bushings for ADVs. DCP does not use brass bushings in its ADVs except in the actuator to permit horizontal mounting.

g. NOMIS query on D-100 valves.

DCP issued a NOMIS query asking if other plants had experienced any problems with the Copes-Vulcan valves. While specific problems were identified, they were not applicable to the DCP ADVs. The overall results of the query indicate that the reliability of these valves is acceptable.

h. Trip to PVNGS to examine corrective actions on ADV failures.

A maintenance team visited PVNGS on October 23, 1989. PVNGS had experienced difficulty in ADV operation following a reactor trip. (Reference: PVNGS LERs 89-001-01, 89-005-00 and 89-005-01.) The PVNGS ADVs are manufactured by Control Components Inc (CCI). The CCI valves are of a significantly different design than the Copes-Vulcan ADVs (drag versus plug type, 12-inch stroke versus 1-9/16-inch) utilized at DCP.

One important similarity is the pilot valve actuation. The PVNGS ADV control scheme is similar to DCP. At PVNGS, the operators on Unit 3 at the time of reactor trip were not aware of the initial pilot valve motion and its impact on valve motion; however, operators on the other units were aware of this. PVNGS enhanced operator training and their site simulator to reflect these conditions. The PVNGS control room has actual ADV stem position indication to augment valve controller demand signal

indication. As discussed in the root cause discussion, the DCP operators were unaware of the demand signal versus stroke characteristics.

Additional information was also gathered from the trip to PVNGS. Following the failure of the PVNGS ADVs, the internals were modified to allow for a larger pilot valve vent area to ensure that the ADV chamber

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fully depressurizes. The plug piston ring design was changed to ensure better live loading. To further ensure maintenance of the piston ring live loading, the ADVs are stroke tested monthly under hot conditions.

3. Event Explanation.

Following the SI, reactor trip, and main steam isolation, control room operators attempted to open ADVs 1-PCV-21 and 1-PCV-22 to control RCS temperature. The hand stations in the control room were taken to manual, the 1-PCV-21 hand station demand was rapidly increased to 25 percent, and 1-PCV-22 hand station demand was rapidly increased to 40 percent demand with no valve motion or steam flow observed.

The ADVs are operated through two stages. The initial valve stem motion opens a pilot valve, which allows the differential pressure across the valve plug to equalize. Once the pilot valve is fully opened, a shoulder on the valve stem engages the plug and further stem motion will initiate plug movement and steam release.

The total ADV stem travel is 1-9/16 inches. Disassembly of 1-PCV-21 and 1-PCV-22 identified the as-found pilot travel as 3/16 inches (12 percent travel) and 9/32 inches (18 percent travel), respectively. The pilot valve travel is equal to the valve stem travel required to engage the main valve plug and begin steam release.

The I&C loop test identified valve stem motion as

beginning at a static 4 percent control room hand station demand for 1-PCV-21 and 16 percent demand for 1-PCV-22. The mechanical and control configurations, when added together, produce the following control room hand station demand values for "pilot valve full open":

1-PCV-21 16 percent
1-PCV-22 34 percent

Based on these results, the ADVs are considered to have functioned correctly. The control room demand indication for both valves was sufficiently close to the "pilot valve full open" position to make this conclusion.

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The conclusion is corroborated by the following:

- Both 1-PCV-21 and 1-PCV-22 opened and controlled normally in response to increased demand following local condition check.
- The operator sent to locally check 1-PCV-21 noted a 4 psi control air pressure. The control air pressure gauge is not routinely calibrated; however, the reading of approximately 4 psi verifies the controller was responding to increased demand, but that the demand was insufficient to fully open the pilot valve and engage the main plug.
- The ADVs stroked smoothly during tests conducted after the event.
- No major problems with the condition of the valve internals were found.

Backpressure in the ADV chamber is not considered to have impacted valve operation. Valve disassembly found minor valve degradation; however, vendor calculations have shown that the chamber will depressurize with a severely degraded plug piston ring and a severely degraded balancing cylinder gasket.

Available information and vendor consultation indicate that the ADVs would have opened from the control room had a higher initial demand signal been placed on the valves.

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James D. Shiffer
Senior Vice President and
General Manager
Nuclear Power Generation

February 21, 1991

PG&E Letter No. DCL-91-033

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Re: Docket No. 50-275, OL-DPR-80
Diablo Canyon Unit 1
Licensee Event Report 1-89-009-01
Reactor Trip and Safety Injection From Steam Line Differential
Pressure Spurious Signals

Gentlemen:

Pursuant to 10 CFR 50.73(a)(2)(iv) and Supplement 1 to NUREG-1022, PG&E is submitting the enclosed voluntary revision to Licensee Event Report (LER) 1-89-009 regarding a steam line differential pressure safety injection/reactor trip. This revision is being submitted for additional information to clarify the sequence of actions during the event, to identify causes for actions during the event, and to identify additional corrective actions to prevent recurrence.

This event has in no way affected the public's health and safety.

Sincerely,

J. D. Shiffer

cc: A. P. Hodgdon
J. B. Martin

P. J. Morrill
P. P. Narbut
H. Rood
CPUC
Diablo Distribution
INPO

DC1-89-OP-N092-02

Enclosure

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*** END OF DOCUMENT ***
